DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

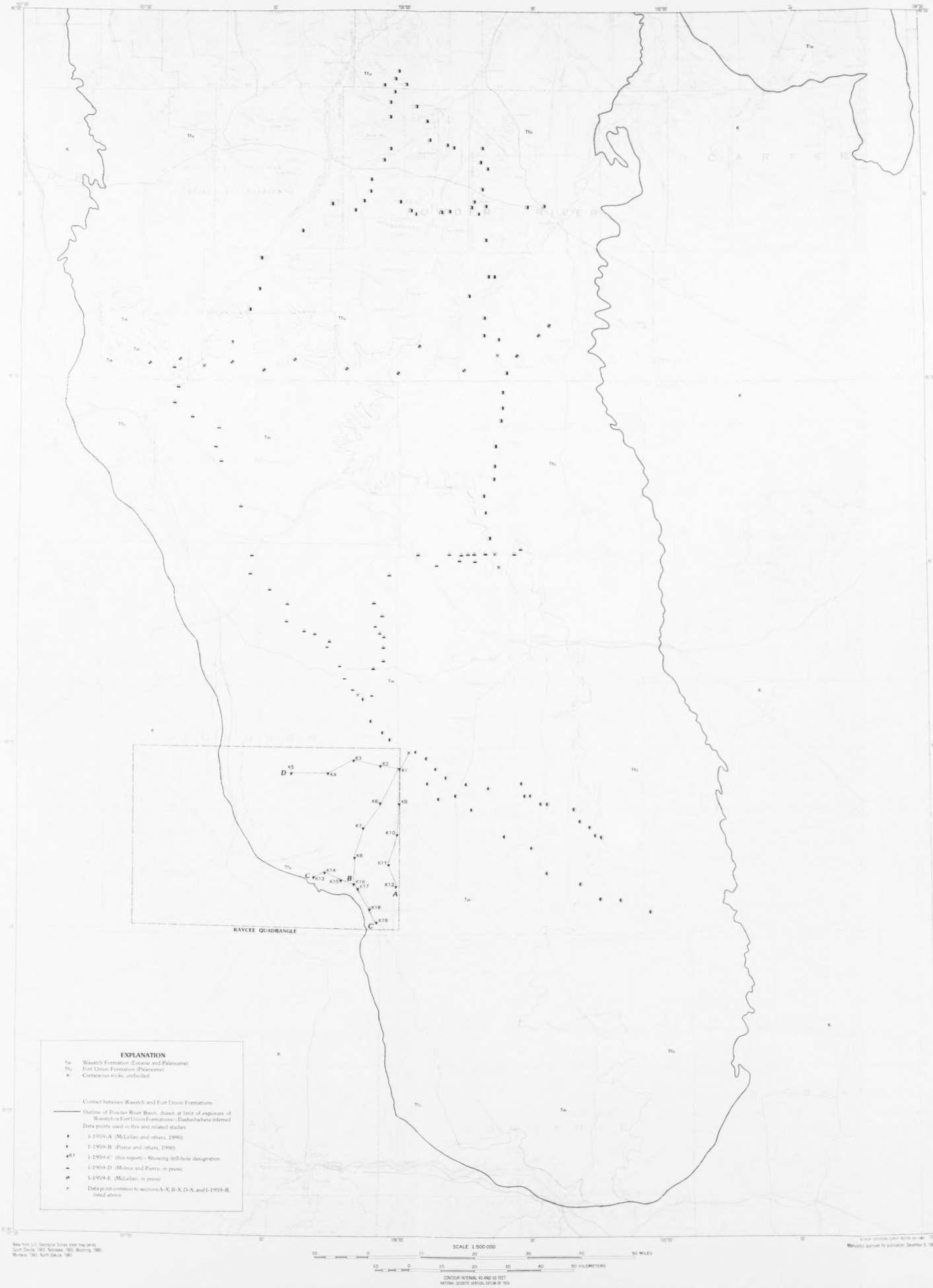

Figure 2. Map showing location of cross sections *A–X*, *B–X*, *C–C'*, and *D–X* within the Kaycee 1° × 1/2° quadrangle and of other stratigraphic framework cross sections in this map series.

INTRODUCTION

The Powder River Basin (fig. 1), containing more than 20,000 sq mi in northeastern Wyoming and southeastern Montana, is underlain by coal-bearing strata of the Paleocene Fort Union Formation and the upper Paleocene and lower Eocene Wasatch Formation (fig. 2). The study area is located in the southwestern part of the basin, along the northeastern flank of the Casper arch, within the Kaycee 1° × 1/2° quadrangle. Interpretations of more than 100 geophysical logs from oil and gas and uranium test holes in addition to those shown in table 1 reveal thick Fort Union coal beds having highly varying geometries depicting the western limit of Anderson-Canyon coal bed(s).

This report is one of a series of related studies conducted by the U.S. Geological Survey in several areas within the Powder River Basin (fig. 2) to determine the stratigraphic framework of the thick and laterally persistent bed or family of coal beds included in the Tongue River Member of the upper part of the Fort Union Formation (as defined by Curry, 1969, 1971; Gibbons and others, 1986, and this report). Published as U.S. Geological Survey Miscellaneous Investigations Series Maps, these five studies include I-1959-A, showing the coal stratigraphy of the northern part of the Powder River Basin (McLellan and others, 1990); I-1959-B, showing the coal stratigraphy of the southeastern part of the Powder River Basin (Pierce and others, 1990); I-1959-C, showing the coal stratigraphy of the southwestern part of the Powder River Basin (this report); I-1959-D, showing the coal stratigraphy of the central part of the Powder River Basin (Molnia and Pierce, in press); and I-1959-E, showing the coal stratigraphy in the area between the town of Decker, Wyo., and Bear Skull Mountain, Mont. (McLellan, in press). The cross sections used in this study can be correlated with cross sections in the adjacent study area to the east and north through the use of hole X, common to both studies (fig. 2). For consistency, coal bed names used in this report are the same as those used in the study to the east by Pierce and others (1990).

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GEOLOGIC SETTING

The Powder River Basin is an asymmetrical structure having a north-south trending axis along its western flank. The basin is surrounded by structural elements consisting of the Miles City arch to the north, the Black Hills to the east, the Hartville uplift and Laramie Mountains to the south, and the Casper arch and Big Horn Mountains to the west (fig. 1). According to Curry (1971), as a product of the Laramide orogeny, basin deformation occurred from Late Cretaceous to early Tertiary time, ending prior to the deposition of the Oligocene White River Formation. Continental deposits of the Upper Cretaceous Lance Formation and lower Tertiary Fort Union and Wasatch Formations filled the basin, totaling nearly 8,000 ft of sediments in areas near the basin axis (Curry, 1971).

Within the study area, the Fort Union Formation is subdivided into three members: the basal Tullock Member, overlain by the Lebo Shale Member, overlain by the Tongue River Member (Curry, 1969, 1971; Gibbons and others, 1986; fig. 3, this report). The Tullock Member measures more than 2,200 ft thick in Mountain Fuel Supply Company's drill hole No. 1 Bonnidee, consisting principally of interbedded sandstone, siltstone, and mudstone. Thick, laterally and vertically stacked, multistoried sandstone bodies having erosional bases are common near the upper part of the member. These are interpreted as channel deposits. The electric log signature typical of the Tullock Member displays a serrated or grassy pattern reflecting the contrast between thin high-resistivity sandstone beds and the interbedded low-resistivity, fine-grained material (fig. 4). The overlying Lebo Shale Member measures as much as 2,100 ft in Shell Oil Company's drill hole Govt 33X–3, consisting of dominantly, fine-grained clastics composed chiefly of thin interbedded mudstone, siltstone, and claystone, and thin discontinuous beds of sandstone and coal. Coal beds greater than 2 ft thick are rare, and when present are usually impure and lenticular. The electric log signature of the Lebo Shale Member contrasts with the underlying Tullock Member in displaying a much more subdued signature, lacking the degree of lateral deflection and serrated character typical of the Tullock Member (fig. 4). The overlying Tongue River Member measures more than 1,200 ft thick in Banks Operation Company drill hole #1 Skyline Federal, consisting of thick, trough-cross bedded erosional-base sandstone bodies interpreted as channel deposits (Childers, 1970; Cross, 1984; Hardie and Van Gosen, 1986; Hardie and Seeland, 1988), thick and laterally persistent coal beds, and thin discontinuous beds of sandstone, mudstone, siltstone, and claystone. Typically, the electric log signature of the Tongue River Member displays a high degree of lateral deflection corresponding to the high resistivity of the coal and sandstone beds and the lower resistivity of the mudstone, siltstone, and claystone (fig. 4). In the northeastern part of the study area, in the vicinity of hole K1 and just outside the study area at hole X, the change in log character between the Lebo Shale and Tongue River Members coincides with a coal bed or pair of beds that correlates with the Upper Kennedy bed (Pierce and others, 1990). Where this coal bed or pair of beds is present, the lower contact of the Tongue River is placed at its base. Where absent, the contact is placed at the point on the geophysical log where the log character changes.

The contact between the Wasatch Formation and the underlying Tongue River Member is locally more difficult to define and is often arbitrary. In the northeastern part of the study area (hole K–1), the contact is drawn at the top of the Roland coal bed after Thom and Dobbin (1924). Where the Roland bed is absent, the contact is drawn at the point on the geophysical log where the overall electric log character of the Tongue River Member displays a decrease in resistivity, particularly for the sandstone beds (fig. 4). Where this resistivity shift is obscured or absent, the contact is arbitrarily placed at the top of the highest Fort Union coal bed as defined by Gibbons and others (1986).

Log annotation and coal bed correlations conducted through the course of this study revealed the presence of a coal-bearing tongue of Tongue River Member strata as much as 350 ft thick in the upper part of the Lebo Shale Member. From the east, the tongue pinches out in a westerly direction in the vicinity of hole K2 of cross section *D–X*. In a north-south direction, what appears to be the width of the coal-bearing tongue extends from a point south of hole K7 of cross section *B–X* and hole K12 of cross section *A–X* to a point to the north, outside the area covered in this report.

DISCUSSION

Principal coal beds shown in the four cross sections of this report are contained in the Tongue River Member of the Fort Union Formation. The thick and laterally persistent coal bed shown in hole K17 of cross section *C–C'* and in hole X outside the northeastern part of the study area (fig. 2) has been given several different bed names in and around the study area. Pierce and others (1990) traced this coal bed in the subsurface from hole X, where it is 115 ft thick, to the northeast, where they correlated it with the Anderson-Canyon coal bed(s) informally called Big George [H.H. Kent, oral commun., 1990]. These same investigators traced the bed from hole X to the east, where they correlated it with the Upper Wyodak coal bed west of the Luck Thunder mine. In addition, they were able to correlate the coal bed(s) immediately below the Anderson-Canyon (shown in cross sections *A–X*, *B–X*, and *D–X*) with the Lower Wyodak coal bed(s), which splits off from the Wyodak coal bed east of the study area. In a previous investigation within the study area Hardie and Van Gosen (1986), not knowing the exact relationship of upper Tongue River Member coal beds to the thick coal beds outside the study area, applied the name "Sussex Coal Zone" (after the nearby community of Sussex, in the Sussex coal field) to the Anderson-Canyon coal bed and its numerous splits to the west.

The four lines of cross section shown in figure 2 are drawn in such a way as to show different profile trends transecting the southeastern part of the large Anderson-Canyon coal-forming swamp. Cross section *D–X* is drawn roughly perpendicular to the western edge of the swamp. Hole X, at the east end of the cross section, represents a point along the western swamp interior where peat accumulation was mostly uninterrupted. To the west along this line, approaching the swamp's edge, the 115-ft coal bed shown in hole X splits and thins, reflecting east-west migration of the western swamp margin. The two coal beds shown in hole K5 are near the swamp's maximum western extent. Cross section *A–X* is drawn roughly parallel to the swamp margin along the western edge of the swamp's interior. Peat accumulation along this line was uninterrupted except for the period of time when the channel sandstone parting was deposited, causing a leader bed to split off from the main bench of coal as shown in holes K1, K9, and K10. Cross section *B–X* is drawn subparallel to the swamp margin. From north to south, this line obliquely transects the swamp margin as evidenced by splitting and thinning of the main bed of coal shown in holes K1, K6, K7, and K8. Hole K16, at the south end of the cross section, shows the coal beds coalescing and thickening to 156 ft, suggesting its location is again within the swamp's interior. Cross section *C–C'* shows a thick, 10-mi-wide southwest-trending re-entrant of the Anderson-Canyon extending from the southwest corner of the main coal-forming swamp. Hole K19 is on the southeastern edge of the re-entrant, represented by a 6-ft-thick coal bed, the only remaining split of the Anderson-Canyon. Proceeding northwest along the line of section, the Anderson-Canyon thickens over a short distance to 124 ft and 154 ft (holes K17 and K16, respectively) at a location within the interior of the swamp re-entrant, then rapidly thins to a 9-ft-thick bed at the northwest edge of the re-entrant shown in hole K13.

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REFERENCES CITED

American Society for Testing and Materials, 1978, Standard specifications for classification of coals by rank: Part 26 of Annual book of ASTM standards: Philadelphia, American Society for Testing and Materials, p. 220–224.

Childers, M.O., 1970, Uranium geology of the Kaycee area, Johnson County, Wyoming, in Symposium on Wyoming sandstones: Wyoming Geological Association Guidebook, 22nd Annual Field Conference, p. 13–20.

Cross, John, 1984, Paleoenvironments of the Upper Fort Union Formation at Pine Ridge, western Powder River Basin, Wyoming: Boulder, University of Colorado, M.S. thesis, 88 p.

Curry, W.H., III, 1969, Synthetic electric logs in subsurface mapping, in Symposium on Tertiary rocks of Wyoming: Wyoming Geological Association Guidebook, 21st Annual Field Conference, p. 93–99.

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Gibbons, A.B., Bieniek, L.H., Brown, J.L., Connor, C.W., Flores, R.M., Hardie, J.K., Johnson, E.A., McLellan, M.W., Molnia, C.L., and Pierce, F.W., 1986, Recognition of stratal units in subsurface Powder River Basin: U.S. Geological Survey Administrative Report, by Tertiary Subgroup, Powder River Basin Project [A chart ensuing from a pilot study, that shows criteria to be used in distinguishing Powder River Basin stratigraphic units for data entry into the National Coal Resource Data System.]

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Hardie, J.K., and Van Gosen, B.S., 1986, Fence diagram showing coal bed correlations within the upper part of the Fort Union Formation, in and adjacent to the eastern part of the Kaycee 30′ × 60′ quadrangle, Johnson and Campbell Counties, Wyoming: U.S. Geological Survey, Coal Investigations Map C–107.

Keefer, W.R., 1974, Regional topography, physiography, and geology of the northern Great Plains: U.S. Geological Survey, Open-File Report 74–50, 17 p., scale 1:1,000,000.

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Pierce, F.W., Johnson, E.A., Molnia, C.L., and Seglen, W.R., 1990, Cross sections showing coal stratigraphy of the southeastern Powder River Basin, Wyoming: U.S. Geological Survey, Miscellaneous Investigations Series Map I–1959–B.

Thom, W.T., Jr., and Dobbin, C.E., 1924, Stratigraphy of Cretaceous-Eocene transition beds in eastern Montana and the Dakotas: Geological Society of America Bulletin, v. 35, p. 481–506.

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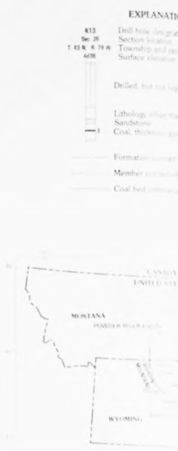

Figure 1. Index map sho... Powder River Basin...

Figure 3. Stratigraphic position of pr... 1 × 1/2 qua...

Figure 4. Diagram showing resistivit... Wasatch Formation and the Tongue... Members of the Fort Union Forma...

Table 1. *Sources of geophysical logs in southwestern Powder R...*

Cross section and drill hole designation	Source
A–X	
X	See first entry, cross section *D–X*
K1	See second entry, cross section *D–X*
K9	Anadarko Production Company, Knight Federal No. 1
K10	Woods Petroleum Corporation, Angell Federal No. 1
K11	Webb Resources Incorporated, No. 1 Federal
K12	Murphy Corp. Argo Oil Corp., Fletcher Federal No. 1
B–X	
X	See first entry, cross section *D–X*
K1	See second entry, cross section *D–X*
K6	Davis Oil Company, #41 Webb Draw Unit
K7	Davis Petroleum Corporation Muller Draw Federal No. 1
K8	Uranium exploration hole
K16	Uranium exploration hole
C–C'	
K13	Uranium exploration hole
K14	Uranium exploration hole
K15	Chicago Corporation and Regular Federal Oil Co., Inc. No. 1
K16	See last entry, cross section *B–X*
K17	Uranium exploration hole
K18	Oil Development Company of Texas, Moore Federal No. 1
K19	W.A. Moncrief, Jr., Crawford Draw Unit No. 1
D–X	
X	Banks Operation Company, #1 Skyline Federal
K1	Davis Oil Company, No. 1 Church
K2	Davis Oil Company, No. 12 Sub Draw Unit
K3	Davis Oil Company, Schaffer Federal No. 1
K4	Davis Oil Company, #1 Hesse
K5	Mountain Fuel Supply Company, No. 1 Bonnidee

CROSS SECTIONS SHOWING COAL STRATIGRAPHY OF THE SOUTHWESTERN POWDER

By
John K. Hardie

1991

MISCELLANEOUS INVESTIGATIONS SERIES
MAP I–1959–C

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REFERENCES CITED

American Society for Testing and Materials, 1978, Standard specifications for classification of coals by rank: Part 26 of Annual book of ASTM standards: Philadelphia, American Society for Testing and Materials, p. 220–224.

Childers, M.O., 1970, Uranium geology of the Kaycee area, Johnson County, Wyoming, *in* Symposium on Wyoming sandstones: Wyoming Geological Association Guidebook, 22nd Annual Field Conference, p. 13–20.

Coss, John, 1984, Paleoenvironments of the Upper Fort Union Formation at Pine Ridge, western Powder River Basin, Wyoming: Boulder, University of Colorado, M.S. thesis, 84 p.

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Gibbons, A.B., Bieniek, L.H., Brown, J.L., Connor, C.W., Flores, R.M., Hardie, J.K., Johnson, E.A., McLellan, M.W., Molnia, C.L., and Pierce, F.W., 1986, Recognition of stratal units in subsurface Powder River Basin, U.S. Geological Survey Administrative Report, by Tertiary Subgroup, Powder River Basin Project. [A chart, ensuing from a pilot study, that shows criteria to be used in distinguishing Powder River Basin stratigraphic units for data entry into the National Coal Resource Data System.]

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Hardie, J.K., and Van Gosen, B.S., 1986, Fence diagram showing coal bed correlations within the upper part of the Fort Union Formation, in and adjacent to the eastern part of the Kaycee 30′ × 60′ quadrangle, Johnson and Campbell Counties, Wyoming: U.S. Geological Survey Coal Investigations Map C–107.

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Pierce, F.W., Johnson, E.A., Molnia, C.L., and Stiglen, W.R., 1990, Cross sections showing coal-stratigraphy of the southeastern Powder River Basin, Wyoming: U.S. Geological Survey, Miscellaneous Investigations Series Map I–1959–B.

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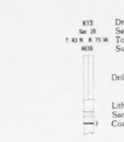
Manuscript approved for publication, December 9, 1988

EXPLANATION



Drill hole designation
Section location
Township and range location
Surface elevation of drill hole, in feet

Drilled, but not logged or described

Lithology other than sandstone or coal
Sandstone
Coal, thickness given in feet

Formation contact—Queried where uncertain

Member contact—Queried where uncertain

Coal bed correlation line

Figure 1. Index map showing location of the Powder River Basin and study area.

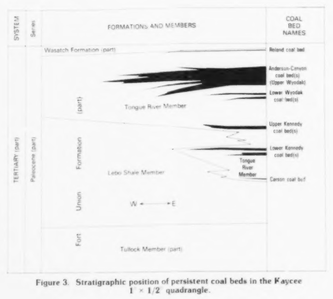


Figure 3. Stratigraphic position of persistent coal beds in the Kaycee 1° × 1/2° quadrangle.

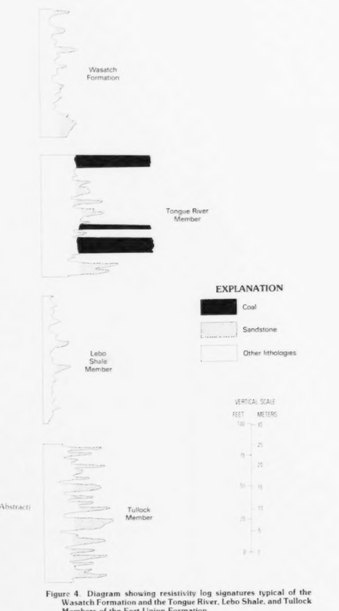
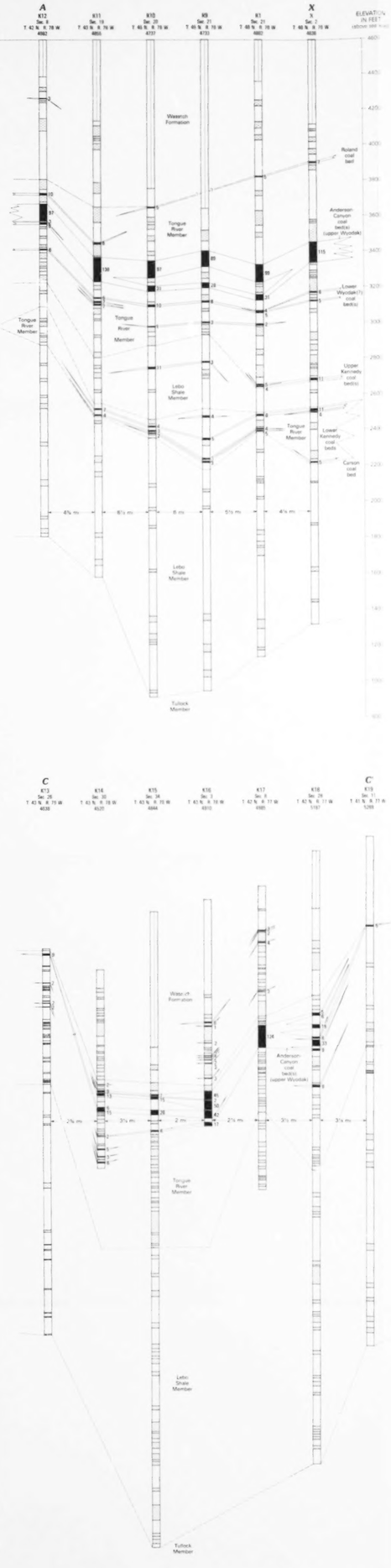
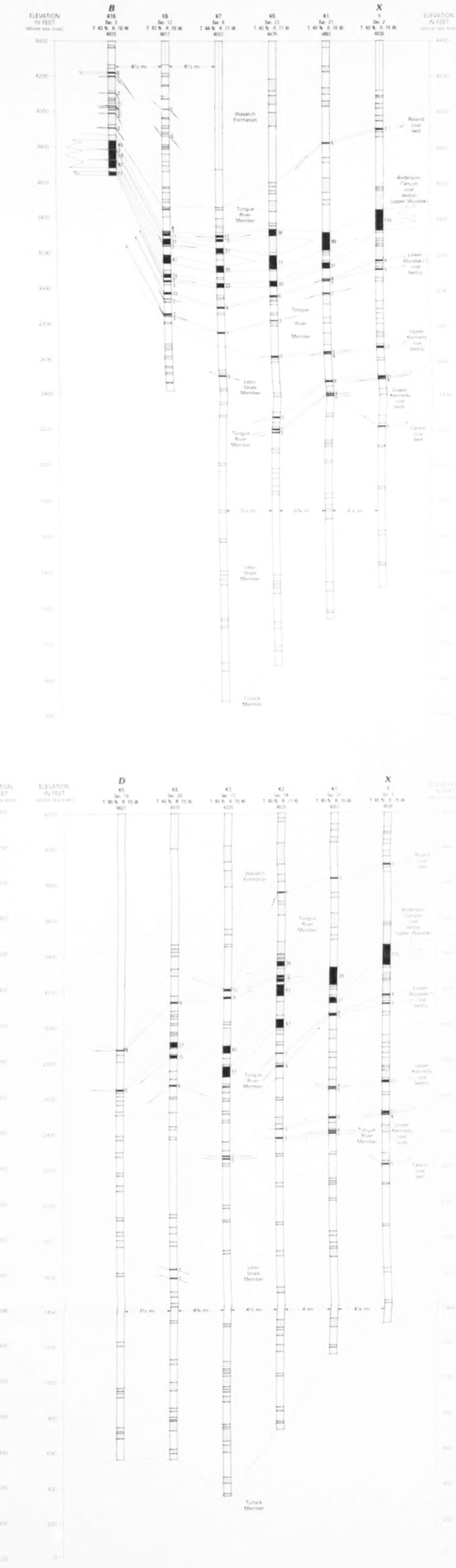


Figure 4. Diagram showing resistivity log signatures typical of the Wasatch Formation and the Tongue River, Lebo Shale, and Tullock Members of the Fort Union Formation.

Table 1. *Sources of geophysical logs used in correlating coal beds in the southwestern Powder River Basin, Wyo.*

Cross section and drill hole designation	Source	Drill-hole location: Section	T.	R.
A–X				
X	See first entry, cross section *D–X*			
K1	See second entry, cross section *D–X*			
K9	Anadarko Production Company, Knight State No. 21–1	NW1/4 NW1/4	21	45 N. 76 W.
K10	Woods Petroleum Corporation, Amarillo-Federal #2	Ctr NE1/4	20	45 N. 76 W.
K11	Webb Resources Incorporated, No. 19–5 Hoss	SE1/4 NE1/4	19	43 N. 76 W.
K12	Murphy Corp.-Argo Oil Corp., Fletcher Canyon Federal	SE1/4 SE1/4	9	42 N. 76 W.
B–X				
X	See first entry, cross section *D–X*			
K1	See second entry, cross section *D–X*			
K6	Davis Oil Company, #41 Haidt Draw Unit	Ctr NE1/4	23	45 N. 77 W.
K7	Dorr Petroleum Corporation Holler Draw Federal	SW1/4 SE1/4	8	44 N. 77 W.
K8	Uranium exploration hole	SE1/4 SE1/4	12	43 N. 78 W.
K16	Uranium exploration hole	SE1/4 NE1/4	1	42 N. 78 W.
C–C′				
K13	Uranium exploration hole	SW1/4 SW1/4	26	43 N. 78 W.
K14	Uranium exploration hole	NE1/4 NE1/4	30	43 N. 78 W.
K15	Chicago Corporation and Republic Natural Gas, Gov't #1	NE1/4 SE1/4	34	43 N. 78 W.
K18	See last entry, cross section *B–X*			
K17	Uranium exploration hole	SW1/4 SW1/4	8	42 N. 77 W.
K18	Oil Development Company of Texas, Moore #1	SE1/4 SE1/4	28	42 N. 77 W.
K19	W.A. Moncrief, Jr., Crawford Draw Unit 3	NE1/4 SW1/4	11	41 N. 77 W.
D–X				
X	Banks Operation Company, #1 Skyline Federal	NE1/4 NW1/4	2	46 N. 78 W.
K1	Davis Oil Company, No. 1 Church	NW1/4 SW1/4	21	46 N. 76 W.
K2	Davis Oil Company, No. 12 Culp Draw Unit 11	Ctr SW1/4	14	46 N. 77 W.
K3	Davis Oil Company, Schaffer Federal No. 1	NE1/4 SE1/4	12	46 N. 78 W.
K4	Davis Oil Company, #1 Hess	SW1/4 SE1/4	20	45 N. 78 W.
K5	Mountain Fuel Supply Company, No. 1 Bonnidee	SW1/4 SW1/4	19	44 N. 79 W.





NG COAL STRATIGRAPHY OF THE SOUTHWESTERN POWDER RIVER BASIN, WYOMING

By
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1991

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